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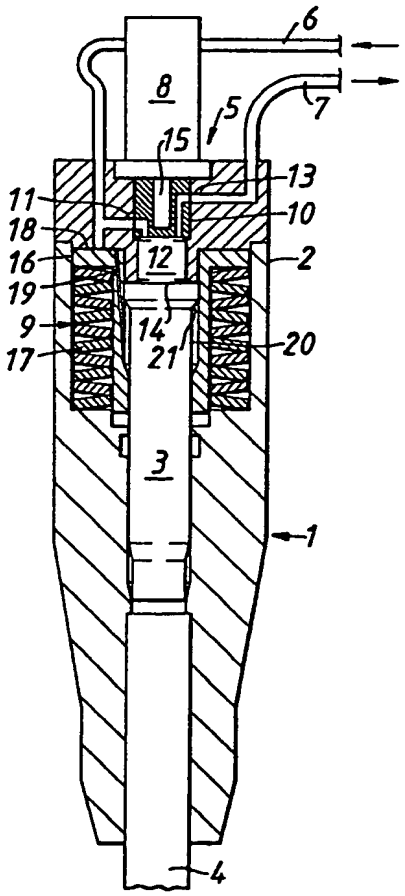
(54) Hydraulically-operated tools

(57) Pressure fluid entering from line 6 drives motor 8, rotating control valve 10. In a first position connection 11 to working chamber 12 is cut off so the fluid enters accumulator 9, depressing member 16 against springs 17. When the valve then makes the connection a rush of fluid passes through it, rapidly driving working member 3 on to hammer-head 4. Further revolution of the valve connects chamber 12 to outlet line 7 just before the connection to 11 is cut off. The fluid which has passed through passage 19 then acts in chamber 20 on the under surface 21 to restore the working member to its original position.



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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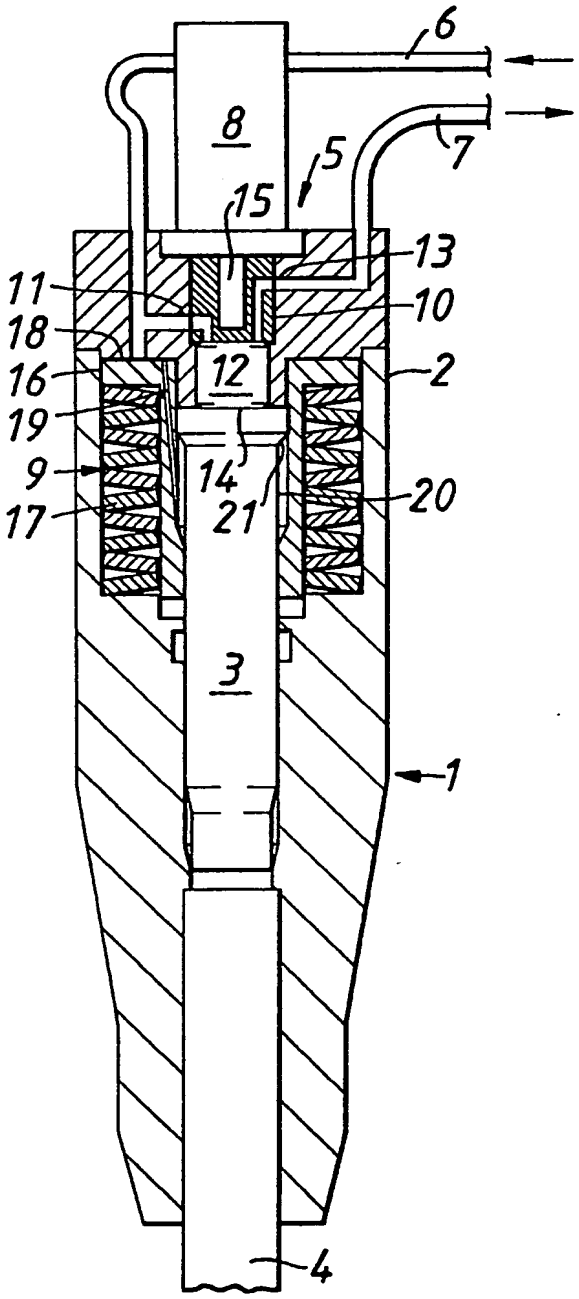

SPECIFICATION

Hydraulically-operated tools

This invention relates to hydraulically-operated tools.

One well known example of a hydraulically-operated tool is a hydraulic hammer. Hydraulic hammers generaly include an impact-applying working member, arranged to be reciprocated by a hydraulic actuating means, acting against the inoperative end of the hammer head (commonly a bar of circular section of which the operative end is pointed). Hydraulic hammers of the prior art have not, however, proved entirely satisfactory as, being subjected to much wear and tear during use, they are prone to breakdown. For example, hydraulic accumulators containing nitrogen gas are used in hydraulic hammers and rupture of the membrane retaining the gas sometimes occurs. Fluid-pressure signals for operational control and dynamic seals to maintain pressure values are also used but such seals are prone to leak unacceptably as the hammer deteriorates during its service life. The range of operating speeds of hydraulic hammers of the prior art is also somewhat limited.

It is an object of the invention to provide a hydraulically-operated tool having an actuating mechanism of simple and reliable form.

The invention provides a hydraulically-operated tool having a working member arranged to be reciprocated by actuating means, wherein the actuating means comprises: an inlet and an outlet for hydraulic fluid, a motor, a hydraulic accumulator connected to the inlet for hydraulic fluid, a first working chamber bounded, in part, by a first face on the working member, and a hydraulic control valve, wherein the control valve is arranged to make a connection for hydraulic fluid between the hydraulic accumulator and the working chamber to drive the working member in one direction, and to make a connection for hydraulic fluid between the working chamber and the outlet for hydraulic fluid to permit the return of the working member in the opposite direction, and the hydraulic control valve is arranged to be operated mechanically by the motor.

Advantageously, the hydraulic control valve is a rotary valve.

Preferably, the motor is a constant displacement hydraulic motor having an inlet and an outlet for hydraulic fluid, the inlet of the motor is connected to the inlet for hydraulic fluid, and the hydraulic accumulator is connected to the outlet of the hydraulic motor.

Preferably, the hydraulic motor is a rotary motor.

Preferably, the hydraulic motor is a gear-type hydraulic motor.

Advantageously, the hydraulic accumulator is connected to a second working chamber bounded, in part, by a second face on the working member, the arrangement being such that pressure of hydraulic fluid in the second working chamber acts, in use, to move the working member in the return direction of the working member.

Preferably, the hydraulic accumulator comprises a mechanical spring arrangement to accumulate hydraulic fluid.

The mechanical spring arrangement may be of a generally cylindrical hollow form.

Advantageously, the hydraulic accumulator means comprises a series of annular metal disc springs.

Advantageously, the working member is generally cylindrical and the hydraulic accumulator comprises a generally tubular spring depressor member surrounding the working member and surrounded by the mechanical spring arrangement.

Preferably, the generally tubular member includes a radially-extending end flange, one face of the flange being arranged to act against an end of the mechanical spring arrangement and the other face being arranged for contact with hydraulic fluid.

The tool may be a hydraulic hammer and the working member may be an impact applying member arranged to reciprocate against the hammer head of the tool.

The invention also provides a hydraulic accumulator in which hydraulic fluid is accumulated in use, by the mechanical compression of a series of disc springs.

One form of hydraulic hammer constructed in accordance with the invention will now be described, by way of example only, with reference to the single figure of the accompanying drawing which is a digrammatic axial cross-section through the hammer.

Referring to the accompanying drawing, a hydraulic hammer 1 for mounting on an excavator or other hydraulic machine comprises a housing 2 in which an impact-appying working member 3 is arranged to be reciprocated against the hammer head 4 of the tool by an actuating means 5. The actuating means 5 comprises an inlet 6 and an outlet 7 for hydraulic fluid, a constant displacement gear-type hydraulic motor 8, a hydraulic accumulator 9 and a hydraulic control valve 10. The hydraulic accumulator 9 is connected to the inlet 6 by a series connection through the hydraulic motor 8.

The hydraulic control valve 10 is connected to a bore 11 connected to the hydraulic accumulator 9, to a first working chamber 12, and to a bore 13 connected to the outlet 7. The first working chamber 12 is bounded in part by a face 14 of the working member 3.

The motor 8 is a rotary motor having a shaft 15 and the control valve 10 is a rotary valve keyed to the shaft 15 for rotation by the motor.

The hydraulic accumulator 9 comprises a

spring depressor member 16 surrounded by a series of annular disc springs 17. The spring depressor member 16 is in the form of a tube with a radially-extending flange 18 at one end. The flange 18 has one face against which hydraulic fluid from the inlet 6 acts, and an opposite face which bears against an end of the series of disc springs 17. Means (not shown) are provided to pre-load the disc springs mechanically in order to increase the spring force against which the spring depressor member 16 acts.

A bore 19 passes through the spring depressor member 16 from the face 18 to a second working chamber 20 surrounding the working member 3 and bounded in part by a face 21 provided on the working member.

The operation of the hammer will now be described.

Hydraulic fluid entering the motor 8 causes the shaft 15 to rotate and, because the motor is of the constant displacement type, a predetermined volume of hydraulic fluid leaves the motor and enters the accumulator 9 on each rotation of the shaft.

The control valve 10 in each rotation of the shaft 15 shuts off the bore 11 to allow hydraulic fluid to be accumulated in the accumulator 9 by the fluid depressing the member 16 against the action of the disc springs 17. On further rotation, the control valve 10 makes a connection between the bore 11 and the first working chamber 12 so that a rush of hydraulic fluid passes from the accumulator 9 into the first working chamber and causes the working member 3 to be projectedly downwardly towards the hammer head 4. Then, when the hydraulic accumulator 9 has discharged its accumulated hydraulic fluid, the control valve 10 connects the first working chamber 12 to bore 13 and shuts off the connection between the bore 11 and the first working chamber. Preferably, the connection to the bore 13 is made just *before* the connection of the bore 11 is shut off so that the working chamber is not sealed off during the downward movement of the working member 3.

Because the volume of hydraulic fluid which enters (and leaves) the hydraulic accumulator 9 is predetermined by the motor 8 exerting a metering function and because the rotation of the control valve 10 is controlled by the motor, it is possible to arrange very accurately the timing of the valve in relation to the volume of fluid entering the working chamber 12 so that the shutting off of the bore 11 takes place just before the working member 3 hits the hammer head 4.

The control valve 10 continues to connect the first working chamber 12 to the bore 13 and outlet 7 after the working member 3 has spent its momentum in an impact with the hammer head 4. The hydraulic pressure in the second working chamber 20 acting on the face 21 now returns the working member 3 to its upper position, the pressure on the face 14 being only that of the outlet line 7. On continued rotation of the control valve 12 by the motor 8, the bore 13 is shut off and the cycle just described is repeated.

The mechanism just described is very reliable because the accumulator employs a robust mechanical spring arrangement and also because the mechanism does not require carefully maintained pressures for its operation. The described mechanism is well suited to operation over a wide range of speeds because of the volumetric metering provided by the motor.

CLAIMS

1. A hydraulically-operated tool having a working member arranged to be reciprocated by actuating means, wherein the actuating means comprises: an inlet and an outlet for hydraulic fluid, a motor, a hydraulic accumulator connected to the inlet for hydraulic fluid, a first working chamber bounded, in part, by a first face on the working member, and a hydraulic control valve, wherein the control valve is arranged to make a connection for hydraulic fluid between the hydraulic accumulator and the working chamber to drive the working member in one direction, and to make a connection for hydraulic fluid between the working chamber and the outlet for hydraulic fluid to permit the return of the working member in the opposite direction, and the hydraulic control valve is arranged to be operated mechanically by the motor.

2. A tool as claimed in claim 1, wherein the hydraulic control valve is a rotary valve.

3. A tool as claimed in claim 1 or 2, wherein the motor is a constant displacement hydraulic motor having an inlet and an outlet for hydraulic fluid, the inlet of the motor is connected to the inlet for hydraulic fluid, and the hydraulic accumulator is connected to the outlet of the hydraulic motor.

4. A tool as claimed in any preceding claim, wherein the hydraulic motor is a rotary motor.

5. A tool as claimed in claim 4, wherein the hydraulic motor is a gear-type hydraulic motor.

6. A tool as claimed in any preceding claim, wherein the hydraulic accumulator is connected to a second working chamber bounded, in part, by a second face on the working member, the arrangement being such that pressure of hydraulic fluid in the second working chamber acts, in use, to move the working member in the return direction of the working member.

7. A tool as claimed in any preceding claim, wherein the hydraulic accumulator comprises a mechanical spring arrangement to accumulate hydraulic fluid.

8. A tool as claimed in claim 7, wherein the mechanical spring arrangement is of a generally cylindrical hollow form.

9. A tool as claimed in claim 8, wherein the hydraulic accumulator means comprises a series of annular metal disc springs.

10. A tool as claimed in claim 8 or 9, wherein the working member is generally cylindrical and the hydraulic accumulator comprises a generally tubular spring depressor member surrounding the working member and surrounded by the mechanical spring arrangement.

11. A tool as claimed in claim 10, wherein the generally tubular member includes a radially-extending end flange, one face of the flange being arranged to act against an end of the mechanical spring arrangement and the other face being arranged for contact with hydraulic fluid.

12. A tool as claimed in any preceding claim, wherein the tool is a hydraulic hammer and the working member is an impact applying member arranged to reciprocate against the hammer head of the tool.

13. A hydraulic hammer substantially as herein described with reference to, and as shown in, the accompanying drawing.

14. A hydraulic accumulator in which hydraulic fluid is accumulated in use, by the mechanical compression of a series of disc springs.

15. A hydraulic accumulator substantially as herein described with reference to, and as shown in, the accompanying drawing.

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